has the significant advantage of stable pinned magnetization at around the blocking temperature, Tb, at which the magnetic coupling bias of the antiferromagnetic layer is lost.

SUMMARY OF THE INVENTION

The problem with the present technology, that an object of the present invention is to resolve, is that the inventors found, the bias point designing in an applied sense current is difficult, especially in device using thin free layer so as to increase the sensitivity of output signal for high density recording.

In a first aspect, the present invention provide a magnetoresistance effect element that attains the object mentioned above comprising a nonmagnetic spacer layer, a first ferromagnetic layer and a second ferromagnetic layer as separated by the nonmagnetic spacer layer, in which the first ferromagnetic layer has a magnetization direction different from the magnetization direction of the second ferromagnetic layer when the applied magnetic field is zero, and the second ferromagnetic layer comprises a pair of ferromagnetic films as antiferromagnetically coupled to each other and a coupling film that separates the pair of ferromagnetic films while antiferromagnetically coupling them, and a nonmagnetic high-conductivity layer adjacent to the first ferromagnetic layer on the plane opposite to the plane at which the first

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ferromagnetic layer is contacted with the nonmagnetic spacer layer.

In the present invention, the magnetoresistance effect device may realize extremely high sensitivity while maintaining a good bias point. Preferably, the MR device may be in the form of a so-called spin valve device (see USP No. 5,206,590), in which the first ferromagnetic layer is not coupled to the second ferromagnetic layer and the magnetization directions of the two layers are perpendicular to each other at zero applied magnetic field. Preferably, the applied magnetic field to change the magnetization of the first ferromagnetic layer may be smaller than that to change the magnetization of the second ferromagnetic layer, and the magnetization of the second ferromagnetic layer is pinned to such a degree that the magnetization direction may not change even in the presence of an applied magnetic field.

In the present invention, the nonmagnetic high-conductivity layer may contain an element of which the specific resistance in bulk at room temperature is not larger than 10 $\mu\Omega$cm, thereby realizing good characteristic, namely, high MR ratio owing to the spin filter effect in the ultra-thin first ferromagnetic layer and low Hcu.

For high density recording and for realizing the increase in MR ratio owing to the spin filter effect of the nonmagnetic high-conductivity layer, the thickness of the

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first ferromagnetic layer may be between 0.5 nanometers and 4.5 nanometers.

In the present invention, the thickness of the nonmagnetic high-conductivity layer and that of the second ferromagnetic layer may be so designed that the wave asymmetry, $(V1 - V2)/(V1 + V2)$, in which V1 indicates the peak value of the reproduction output in a positive signal field and V2 indicates the peak value of the reproduction output in a negative signal field, may fall between minus 0.1 and plus 0.1.

In the present invention, the MR device may satisfy the conditions of 0.5 nanometers $\leq$ tm(pin1) $-$ tm(pin2) $+$ t(HCL) ≤ 4 nanometers and t(HCL) ≥ 0.5 nanometers, in which t(HCL) indicates the thickness of the nonmagnetic high-conductivity layer (in terms of the Cu layer having a specific resistance of 10 $\mu\Omega$cm), and tm(pin1) and tm(pin2) indicate the magnetic thicknesses of the pair of ferromagnetic films, respectively, in the second ferromagnetic layer in terms of saturation magnetization of 1 Tesla, where pin 1 is of one of the ferromagnetic films disposed adjacent to the nonmagnetic spacer layer and pin2 is of another one of the ferromagnetic films. Satisfying the conditions noted above, the MR device may realize the wave asymmetry falling between minus 0.1 and plus 0.1 and high MR.

In the present invention, the first ferromagnetic layer may have a magnetic thickness, thickness $\times$ saturation

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